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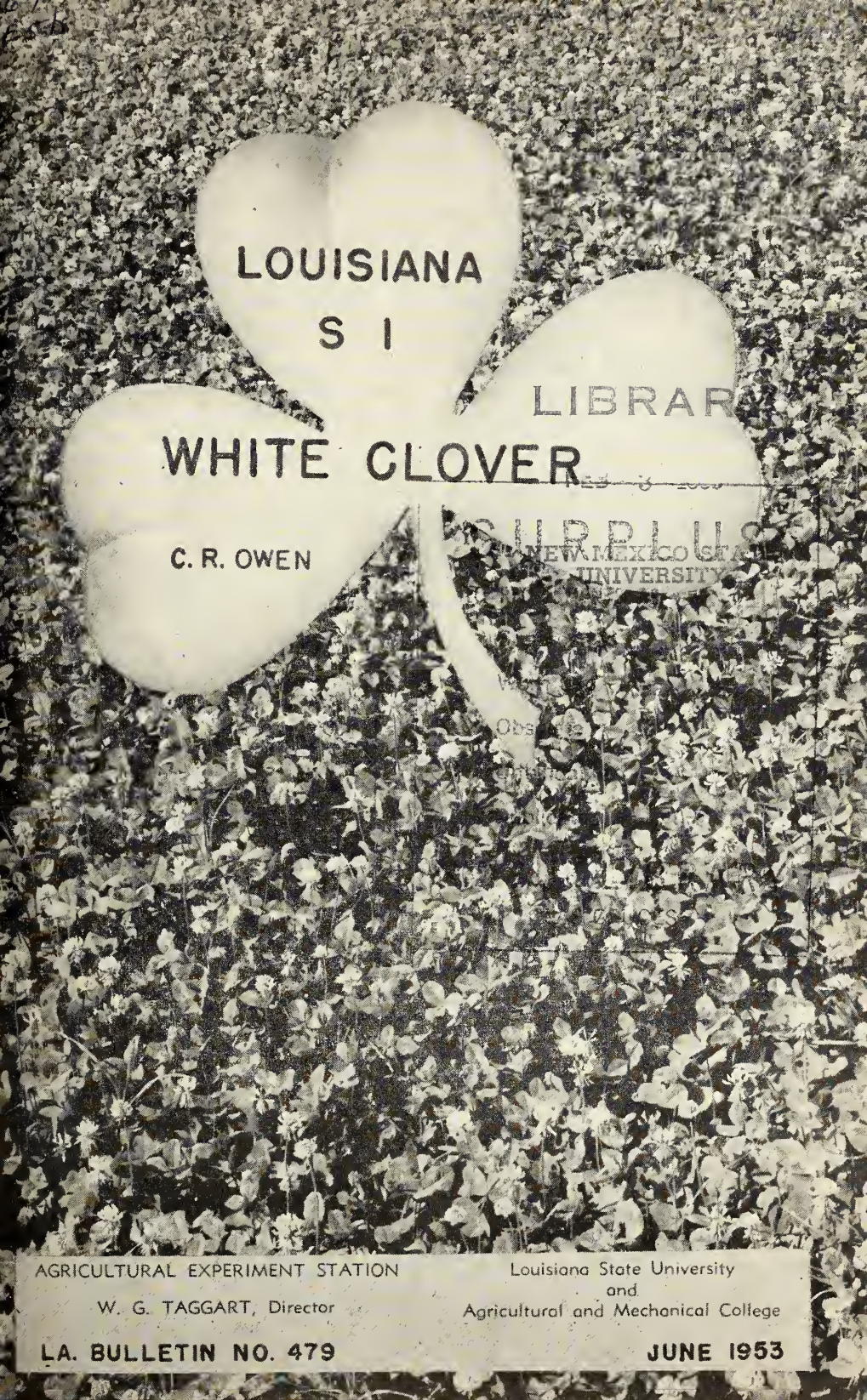
Louisiana S1 white clover

Corbin Ransom Owen



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White clover has contributed much to the development of grassland agriculture in Louisiana as well as in the remainder of the southeastern region. It was probably among the first legumes used for grazing in the state. Although little is known of its earliest use, reference is made to white clover during the nineteenth century which would indicate that its introduction into this area was much earlier.[1] In an early bulletin by the Louisiana Agricultural Experiment Station is this brief reference: "*Trifolium repens* (white clover) grows wild and luxuriantly all over the south and middle of Louisiana and affords our earliest spring pastures."[2] Prior to comparatively recent times this crop has not been seeded by farmers but has become spread over much of the region of south and central Louisiana by livestock, flood waters, and other natural means.

White clover is considered native to all countries of western Europe. From there it has spread to many parts of the world. In North America it is found growing from Newfoundland to British Columbia and from Florida to California. It is found in every continent and most of the major islands, including Greenland.[3]

An adaptation range for a plant species such as the one described for white clover is unusual, especially when in so much of the area from the Arctic Circle to the subtropical region it has apparently appeared without having been intentionally introduced by man and returns year after year either as a perennial, or reseeding naturally and coming back each season in natural stands. In fact, white clover is said to have accompanied the spread of western civilization in America so closely that it was called "white man's foot grass" by the Indians. It would be expected that many different forms would have arisen, as has been the case with corn. Yet, up to the present time only three types are recognized: (1) the large type, represented by Ladino; (2) the intermediate type, in which Louisiana white, New Zealand white, and others are so classed; and (3) the low growing type of which the New York wild white clover is an example. These types are products of natural selection within the regions of their respective origin. The differences among them are in size and in general performance. It is generally regarded that considerable variation is present in each type, which is borne out by the extent to

[1]Honorable J. B. Robertson, *Memorial and Explorations in Relation to the Agricultural, Mineral and Manufacturing Resources of the State,* (January 1867).

[2]*Forage Crops, Grasses, Clovers and Small Grain,* Bulletin 19, Second Series, (Louisiana Agricultural Experiment Station, 1892), p. 543.

[3]Adelia G. Erath, *White Clover (Trifolium repens L): A Monograph,* (London: Duckworth and Co., 1924), pp. 1-3.

which white clover has become spread in the various climates of the world. Undoubtedly, many diverse sorts will be developed from this species as the needs arise.

A different type of white clover than those referred to above is needed in the southern region. Louisiana white clover, as is generally known, behaves normally as a winter annual. It blossoms and produces seed in late April through May and dies soon after, usually in June. It emerges from seed in late fall and is usually present in pastures during early spring. Under normal conditions, only about three or four months of grazing can be expected from it each year. The value of white clover would be very much increased if its grazing season were extended. A breeding program was initiated in 1945; the principal objective was to establish within Louisiana white clover more heat and drought tolerance.

This work was started by making a survey of the clover fields within the state in August, 1945. Seed heads were collected from plants which had survived the summer. The seed were removed from these heads and were used as the beginning of the white clover breeding program. Seed from the larger, better filled heads were selected for use in planting progeny rows. Seeds from heads less well filled were used in making additional random space-plantings in an adjoining area. Seed were germinated in the greenhouse during the winter and the plants transferred to the field in April, 1946.

Observations were made at intervals during the spring and summer, survival counts being made in early September. Plants with as many as a few green leaves were counted as surviving. (The percentage of plants surviving the summer is given in Table 1.) Counts were made only on those plots which were planted as progeny. The average survival is high for Louisiana white clover, indicating that selection for heat and drought tolerance characteristics in white clover was effective.

TABLE 1. Summer Survival of Space-Planted White Clover Progeny from Seed Heads Collected from White Clover Fields, August 1945

Per Cent	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	Mean	C. V.
Number	3	2	8	9	8	12	9	5	6	10	6	10	13	10	7	6	7	1	56.6 ± 1.0	38.5 ± 2.75

Selection of Clones

After the weather conditions had become favorable for revival growth of white clover, the plants were reclassified on the basis of the quantity of growth as indicated by the area the plant had covered during the season and the ability of the clone to maintain the forage over the area. Finally, from approximately 4,000 seedlings transplanted into the nursery in April, 35 were selected the following October. The plants selected to be used as clones for further evaluation studies had spread over an area of five square feet or more and had maintained coverage over this area. It was necessary to reduce the number to 25 due to insuf-

ficient testing area. Five of the extra clones were transplanted into the guard plots at the side of the test plots.

Evaluation of Clones

The clone evaluation experiment was conducted during the seasons of 1947 and 1948. The clones were transplanted in the center of plots 14 feet square. The plots were arranged on a square block with five plots on a side. This experimental design, known as the lattice square, was completed with three replications. Within these plots each clone was observed for vigor, as indicated by the rate it had spread; each plot was observed for heat and drought tolerance indicated by the amount of white clover left at the end of the summer. Forage harvests were made each year at such time as the seed was matured. Seed was threshed from the forage after it had been dried and weighed, with yields of both seed and forage recorded. (The results of these experiments are summarized in Table 2.) From this experiment Clones Number 6, 15, 21, and 23, together with Clone 26 not listed among these, were superior and were used in the clone combination of Louisiana S1.

Further testing techniques were used in evaluating the clones. These techniques are considered as routine for such crops and are described

TABLE 2. Comparative Growth and Development of Selected Clones, 1946, 1947, 1948

Clones	Area Spread, Sq. Ft.			Per Cent Cover		Forage Yield		Seed Yield	
	1st Yr. 1946	1947	1948	1947	1948	1947	1948	1947	1948
1	7.56	80.00	94.1	53	8.6	1053	1562	66.0	95.2
2	5.52	96.76	96.9	62	11.8	2239	2482	177.0	155.0
3	5.98	56.00	74.5	10	8.1	1176	1737	52.0	75.0
4	10.56	53.30	79.9	9	4.6	882	1913	52.7	98.0
5	8.12	89.30	132.5	86	28.1	1783	3679	99.3	161.0
6	9.00	97.00	139.3	91	49.1	2314	3971	170.0	141.0
7	11.30	83.30	92.0	65	31.1	797	2146	41.0	61.0
8	6.75	90.60	88.7	57	20.2	1527	1781	93.0	89.0
9	8.96	82.00	114.1	67	6.0	1394	2920	104.0	158.0
10	7.02	93.00	80.8	63	10.0	1385	2394	68.0	107.0
11	6.25	92.30	101.2	42	34.4	1442	3095	60.0	83.0
12	7.00	91.00	107.6	16	32.5	1365	1503	111.0	133.0
13	5.98	87.30	89.9	27	20.5	1603	2380	89.0	99.0
14	12.00	70.00	91.0	45	16.9	1375	2102	51.0	76.0
15	14.82	88.30	146.9	86	31.8	1878	3635	63.0	171.0
16	10.15	76.00	98.5	42	16.5	1138	2161	46.0	77.0
17	6.67	86.00	102.3	42	11.6	1764	2905	64.0	111.0
18	5.46	82.00	80.7	62	28.5	939	1387	30.0	67.0
19	5.98	40.00	66.8	12	17.9	322	1840	58.0	84.0
20	8.84	80.00	98.8	38	3.5	1422	2686	107.0	163.0
21	7.83	96.00	120.9	84	41.0	2694	3431	90.0	107.0
22	9.18	83.70	78.1	48	34.2	1850	2029	81.0	75.0
23	11.10	94.00	126.9	87	30.0	1840	3387	90.0	152.0
24	10.89	75.00	92.0	12	10.8	636	1986	58.0	96.0
25	9.90	53.00	80.5	24	13.5	597	1708	48.0	59.0
LSD 5%	....	12.90	33.0	25.6	26.3	1144	349	47.0	43.0

fully by Johnson.[4] White clover is cross pollinated; thus, each seed that is set must have received pollen from a blossom of another plant. The clones proved to be perennial; that is, they lived continuously throughout the three years. It appeared that with ordinary care they would continue to live indefinitely. They had also shown, later, to possess good combining ability. (See Table 3.) Consequently it was evident that the most effective means of utilizing them was by recombining the five into a synthetic variety.

TABLE 3. Forage Yield Distribution for Polycrosses, Synthetic Varieties, and White Clover Varieties, 1952, Second Year After Seeding

Entry	Yield Pounds per Acre Dry Matter				Total
	Jan. 16	March 6	May 8	June 9	
S1, First Year	1111	2360	3763	944	8178
S1, Second Year	1029	2236	4099	1265	8629
6 Polycross	1204	2533	4205	877	8819
15 Polycross	1055	2600	4495	1055	9205
21 Polycross	1319	2569	4193	899	8980
23 Polycross	1212	2162	4624	1399	9397
26 Polycross	1325	2504	4219	1399	9447
Louisiana White	275	2020	3752	555	6602
Ladino	604	1725	3555	2520	8404
LSD 5% Point	118	302	651	426	1053

Forming the Synthetic Variety

The synthetic variety was formed by transplanting the clonal material into an isolated intercrossing block. The first intercrossing block was planted in the fall of 1948. The clonal lines were transplanted into rows, each clone to a row in sets of five. There were several sets of rows in the block, so that the clones could be arranged in such a manner as to insure maximum intercrossing between all clones. In order to insure more complete intercrossing among the clones, hives of honey bees were located at one end of the field.

Testing the Variety

Seed was harvested from the clone rows the following spring. All clones were harvested and threshed in mass and, through the process of threshing and cleaning, the seed were thoroughly mixed. This seed was used for planting the forage yield evaluation experiments as well as for planting seed increase fields. Forage yield experiments were planted to compare this combination of clonal lines with Louisiana white clover, Ladino, and other strains from different sources. (The results of the forage yield evaluation are given in Table 4.) Yields of only Louisiana white and Ladino are given since most of the other entries did not differ significantly from these. It was evident from the comparative forage

[4] I. J. Johnson, "Forage Crop Breeding," *Forages, the Science of Grassland Farming*, Hughes, Heath and Metcalfe, (Ames: Iowa State College Press, 1952), p. 124.

TABLE 4. Forage Production with Varieties and Strains of White Clover: Total Annual Yield on Olivier Silt Loam

Entry	Forage Yields				
	Dry Matter per Acre				%
	1950	1951	1952	Avg.	Check
Louisiana White Clover S1	8333	3427	7809	6523	127
Ladino, Certified	6749	3643	7577	5990	117
Louisiana White	6696	3043	5632	5124	.....
Least Significant Difference (5%)	207	294	249		

yields that the synthetic combination was definitely superior to the regional strain Louisiana white clover. Plans were made to increase the seed supplies for release to the farmers of Louisiana. The new combination was first called Louisiana Synthetic 1 and it later became known as Louisiana S1 white clover. Forage yield trials were planted at six locations in Louisiana outside the Baton Rouge area. The results are not included, but the synthetic variety was reported as superior to other varieties and strains of white clover tested at each station.

The seasonal growth distribution of the varieties and strains of Louisiana S1, Louisiana white, and Ladino is given in Figures 1 and 2. Louisiana S1 produces more forage from late fall and early winter until

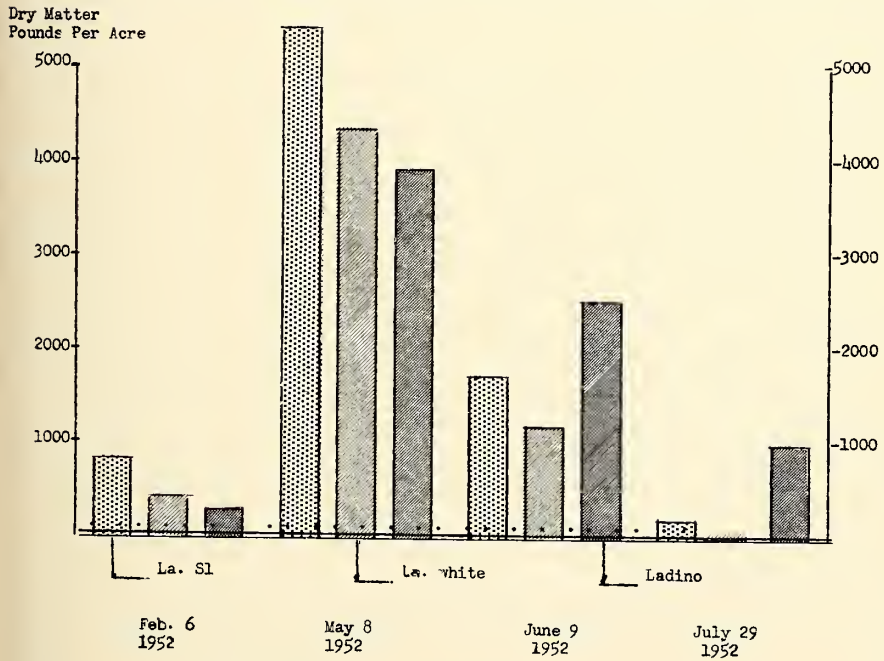

FIGURE 1. Forage production with varieties and strains of white clover: first season growth after seeding.

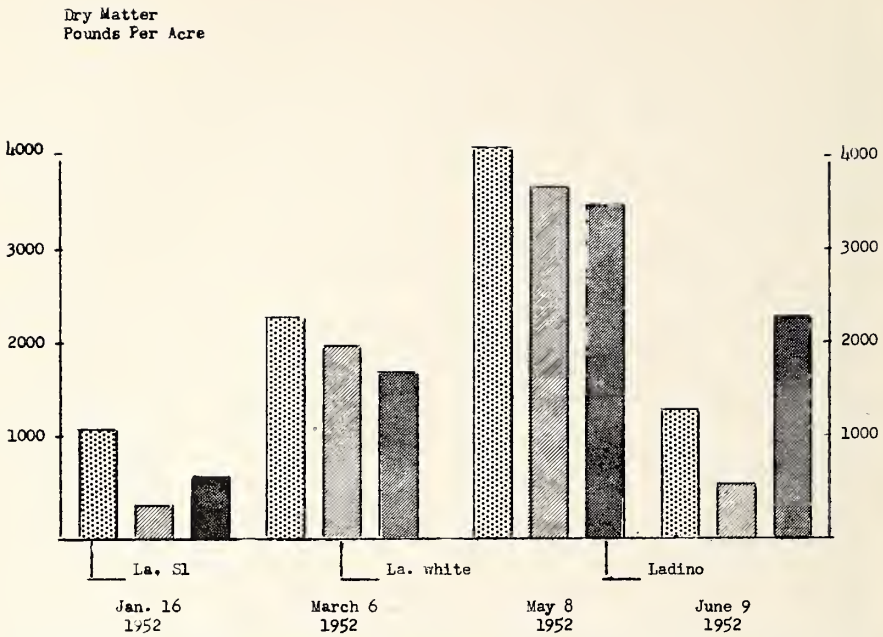

FIGURE 2. Forage production with varieties and strains of white clover: second season growth.

May than either Ladino or Louisiana white from tests of both the first and second year after seeding. Ladino is more productive than Louisiana S1 or Louisiana white after May through June and July. It thins out during late summer and, since no seed are produced, would require reseeding each fall. Figure 4 is a photograph of Ladino growing under artificial light in the greenhouse. Blossoms are formed readily at day lengths of 14 to 16 hours per day. Louisiana S1 blossoms at about the same rate as the common regional Louisiana white variety in a similar environment.

The Program of Seed Production with Louisiana S1 White Clover

Seed production with Louisiana S1 white clover involves the routine of maintaining the parent clones by the Experiment Station, establishing the intercrossing block at regular intervals of from two to three years, increasing the seed from this block to produce foundation seed, and producing an adequate supply of foundation seed. The foundation seed is planted by the seed grower who in turn produces seed for certification.

The parent breeding stock represented by the five clone lines is kept on the Experiment Station farm. Each clone is grown in a plot about 1/500 acre in size. They are transferred every other year to fresh, clover-free soil where the clones grow and produce the cuttings necessary for planting the intercrossing block. Transferring the clones to fresh beds

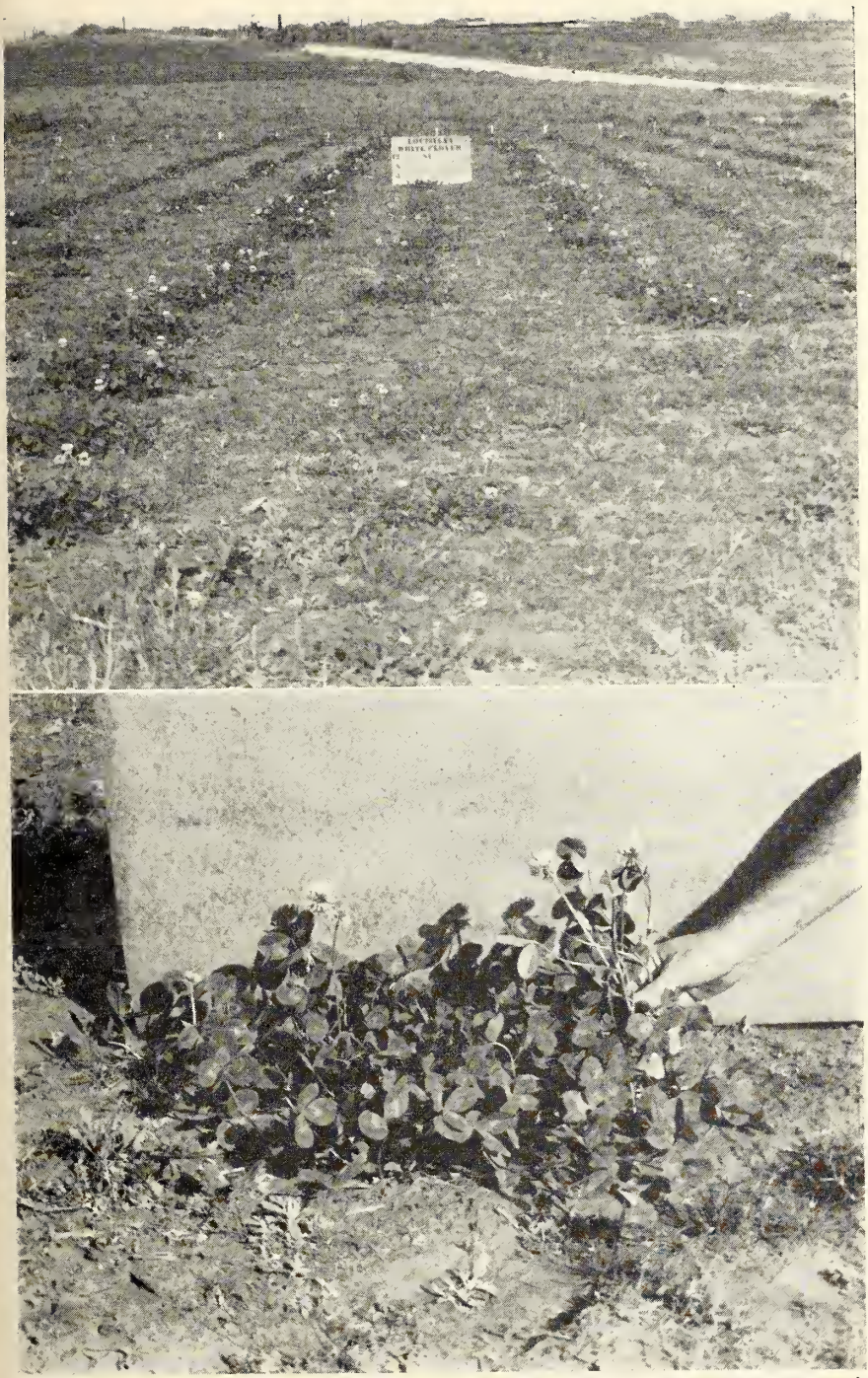

FIGURE 3. Intercrossing blocks are transplanted from clone cuttings. Each clone is planted to a row. The five clones occur in sets of five rows, repeated several times over the field. Below: Clone piece developed from small cutting transplanted to field in November, photographed following March.

every other year is a necessary precaution against contamination from seedlings arising from seed produced by the clone. The clones which go into the synthetic variety must be kept pure for as long as the variety is in the seed production program.

At this stage in the program it is thought highly desirable, if not absolutely necessary, to transplant clone cuttings into new intercrossing blocks every second or third year, if for no other reason than to maintain a supply of breeders' seed. The hazards to clone material in the field are considerable and whenever the clone is thinned by weed competition or machinery operation, seedlings arise in the places where thinned. Intercrossing blocks have been from three-fourths to one and one-half acres in size. Sufficient breeders' seed has been produced from these blocks to plant 20 to 40 acres for the production of foundation seed.

From the intercrossing block through the routine of increasing the seed for release to farmers for growing certified seed, two or more generations have elapsed. Under normal conditions no additional changes are expected to occur in the yielding ability of the variety. A synthetic variety which is the result of the recombination of selected non-inbred plants or clones is expected to maintain its vigor indefinitely under normal conditions.

Certified Seed Production

In the foregoing sections a brief description has been given of the production of breeders' seed and foundation seed. The third and last step between the developmental techniques used in the production and release of an improved strain or variety of field crops is the production of certified seed. Certified seed, according to Hollowell, is seed of known genetic identity and of high germination, purity, and freedom from harmful weed seed.[5] Standards for the production of certified seed for Louisiana S1 white clover, as well as for other crop seeds, may be obtained by writing the certifying agency of the state. For Louisiana the certifying agency is the State Department of Agriculture. The standards are set up to safeguard the quality the buyer of certified seed has a right to expect. The quality found in certified seed is the result of the extra precautions taken prior to the time the seed is bagged. This supply must be kept pure or much of the improvement bred into the variety will be lost.

Aside from the care necessary to fulfill the requirements set up by the standards for certification, the production of certified seed of Louisiana S1 differs very little from that of ordinary white clover. The average acre yield of white clover seed for Louisiana for the period 1939-51 is 47.4 pounds per acre.[6] On the other hand, acre yields of 200 pounds or more are not unusual in the state. Preliminary to any other plans for seed production, an effort should be made to increase the acre yield. While yields of 50 to 75 pounds per acre may be profitable in some instances,

[5]E. A. Hollowell, "Legume and Grass Seed Production," *op. cit.*, p. 110.

[6]*Acre Yields and Production of Field Seed Crops, 1939-51,* (U.S.D.A. Bureau of Agricultural Economics, June 1952), pp. 14-15.

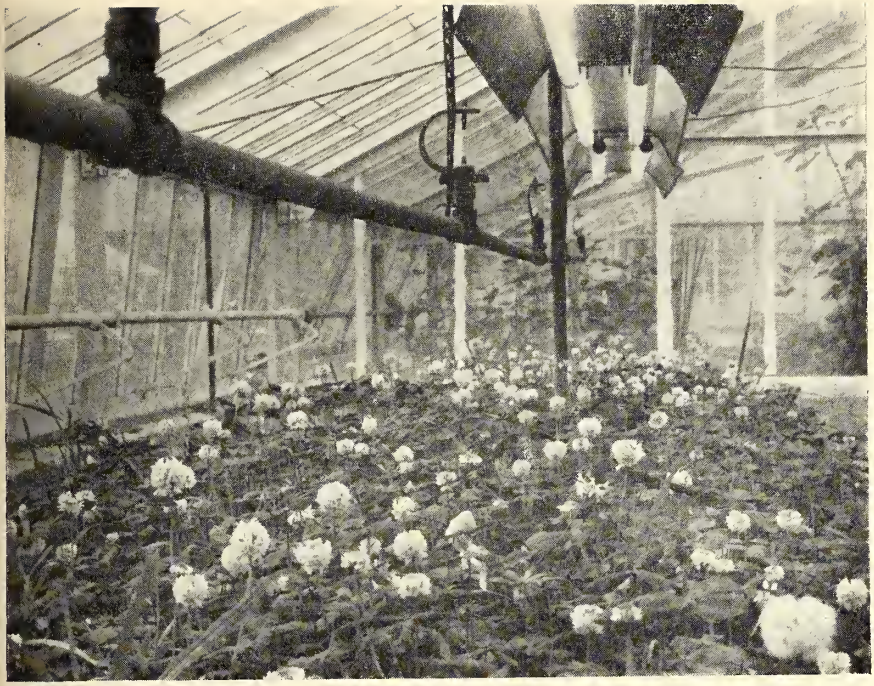

FIGURE 4. Ladino blooms freely under long light periods. With 14 to 16 hours of continuous light in the greenhouse, this bed of Ladino blooms nearly the entire year if protected from intense heat during the summer.

an acre production two to several times that amount would be much better. From the standpoint of improving the production per acre there are no substitutes for the practices of: (1) using adequate quantities of the right kinds of fertilizers, (2) preparing the land well for furnishing the best type of seedbed, and (3) keeping the weeds under control after the clover begins growing. Other factors for consideration after these have been provided for are: (1) rate and time of seeding, (2) seed inoculation, particularly on land suitable for producing certified seed, (3) supply of pollinating insects, and (4) seed harvesting and cleaning machinery. Success in seed production with white clover as well as with any other crop will depend to a large extent upon attention given to it as a crop and not just as a sideline to pasture or other uses to which the clover forage may be channeled. Certainly this clover is meant to be used principally as a pasture crop, but, as with any other crop, with new strains a supply of seed must be made available before it can be used for the purpose intended.

There is practically no information available regarding the plant nutrient requirements for seed production with most small-seeded forage crops. It may be regarded as safe to follow the recommendations for

clover pasture except that heavier rates should be more profitable for seed than for pasture.

Land preparation is more important with a crop which is to occupy the land for two or more years than for those which occupy the land only one season. Any inadequacies in the seedbed preparation may be reflected in the performance of the crop during the entire period the crop occupies the land. Clover seed planted on a loose, cloddy seedbed is seriously handicapped regardless of the degree of fulfillment of the requirements of other practices.

Weed control is as essential with a crop like white clover seed as with any other crop. Weeds are generally controlled by mowing. If mowing is used for control, it should be started as early after the crop begins growing as is needed. It may be necessary to clip the clover back in the early spring to prevent excessively large growth. Chemical weed control may be used under certain circumstances.[7] White clover is not affected by 2-4-D applied in the right concentrations according to the report from the Mississippi Experiment Station.

Methods and Rates of Seeding

The rate of seeding Louisiana S1 is about five pounds per acre. This is considered to be in excess of the absolute need if weather conditions are favorable. However, for insurance in obtaining a stand, as well as to have the ground covered with clover plants as early as possible, this excess is recommended. The time for seeding is middle to late October, provided the soil moisture condition is favorable. It does not pay to seed white clover in dry soil, especially if the seed are to be inoculated. The earlier the seed is sown after the soil condition becomes favorable, the better.

The seed should be planted on a smooth, firm seedbed; a light mulch is preferred to receive the seed. The land should be firmed with a standard weight cultipacker as soon as possible after sowing. The cultipacker following the light mulch will cover the seed adequately on most soils.

Weeds

Certain weeds found in white clover fields may not be controlled by normal mowing or other known means. Dodder is the principal example in this class. Dodder seed is a most objectionable noxious weed seed and every care should be exercised to keep clover seed from getting contaminated with it. It is more severe during years that white clover is late in reaching maturity. When a white clover field becomes severely infested, it is usually best to plow the crop under and follow it with a cultivated row crop. When light infestation is present, it may be destroyed by burning. The field should be inspected for dodder early and it may be destroyed by merely removing it from the field by hand. Curled

[7] "Chemical Weed Control Guides for 1953," *Mississippi Farm Research*, (February 1953), p. 3.

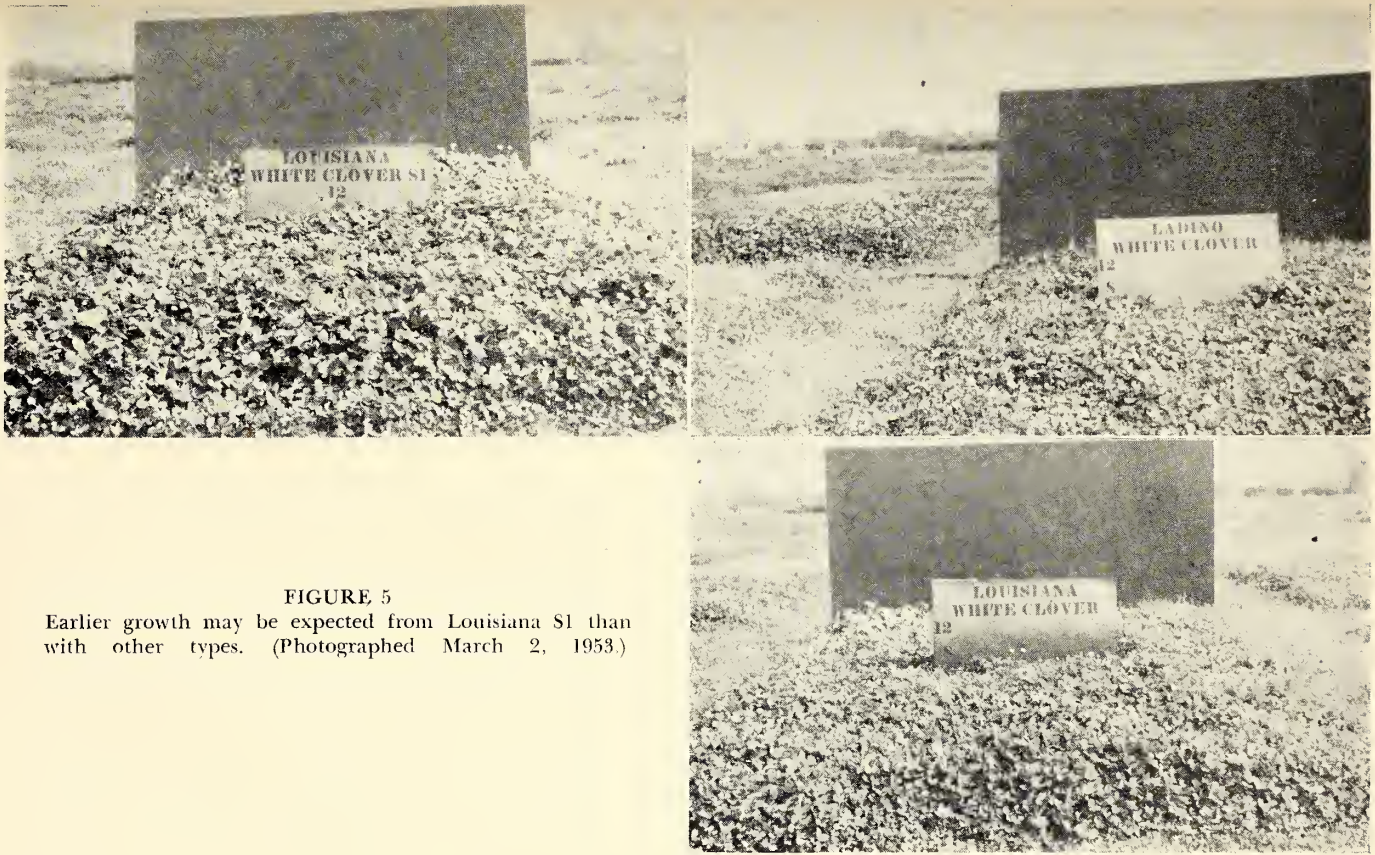

FIGURE 5
Earlier growth may be expected from Louisiana S1 than with other types. (Photographed March 2, 1953.)

dock (*Rumex spp.*) is difficult to control in seed fields if it gets a start. It cannot be controlled easily by either mowing or burning. Some farmers have reported success with chemical control of this weed.

Pollination

As mentioned before, white clover is cross pollinated and is dependent upon pollinating insects for seed setting. Wild stands of white clover may be adequately pollinated by wild bees. With the increase in the acreage of white clover and other such crops, the supply of natural pollinating insects is sure to become inadequate. Farmers considering seed production with white clover should investigate the possibilities of acquiring as many bees as is practical to do the pollinating. One hive per acre is advocated by some authorities.

Seed Harvesting

White clover seed may be matured sufficiently for harvesting four to five weeks after the peak blooming season has passed. The peak of blooming occurs just after the decline in growth begins. The seed are mature in a head usually after the supporting stems lose the green color. Harvesting should be done when there are more mature heads than immature heads. Actually the percentage of mature heads should be about 75 or more. Weather reports should form the basis for determining the day for mowing the clover after this stage of maturity is reached.

Harvesting is done by cutting clover with a mower. It is allowed to cure in the swath, after which it is either threshed from the swath by the use of a combine with a windrow pickup attachment or windrowed and threshed from the windrow. If the growth is heavy and the weather is favorable for drying, it may be picked up from the swath. It should be windrowed where the forage is not heavy enough to be picked up from the swath or when weather conditions make curing slow in the heavier forage growth. In either event the clover should not be disturbed unnecessarily after the seed heads are dry.

Most combines or threshing machines now available were not designed especially for threshing small seed, but were designed for threshing cereal grain and larger seed. Very careful adjustment may be necessary for best results from these machines with clover seed. Every precaution should be taken to make such necessary adjustments as soon as is practical after the threshing operation begins.

Cleaning the Seed

Two types of seed cleaning machines are usually required to clean white clover seed after it has been threshed with the standard combines or thresher. It is first run over screens which remove the foreign material that differs in size from the seed. This machine is also equipped with a blower which fans out some of the light material similar in size to white clover seed. For complete cleaning, a second machine known as the gravity seed separator is almost essential. These machines are costly

and require some skill to be operated successfully. It will probably be more practical for the average seed grower to depend on the commercial seed cleaners for cleaning his seed. Growers of certified seed should contact the certifying agency for a list of seed cleaning plants that meet the requirements for cleaning such seed.

Louisiana S1 White Clover for Pasture

The characteristics of S1 white clover were bred into it for the sole purpose of making the variety more valuable for use in pastures in Louisiana. The fact that it revives earlier in the fall and lasts later into the summer should make this variety well worth its adoption for use in pastures. At this time no comparative data are available in terms of animal gains to substantiate the claim of the superiority of Louisiana white clover. It was only during the past two seasons that seed supplies have been available for planting in sizeable acreages. During 1952 it was used for grazing and the reports were favorable. Forage yield tests from small plots have been planted on the branch Experiment Station farms in other areas of the state during the past three years. The results from these have been in favor of Louisiana S1 white clover. It is expected that this variety of clover will prove beneficial in improving fields of Louisiana white clover now found growing in pastures over the state. It should be better in new pastures where white clover has not grown before.

Summary

Louisiana S1 white clover is a synthetic variety developed by intercrossing five clonal lines selected from Louisiana stocks of white clover.

The clones were selected on the basis of their ability to yield and to tolerate hot, dry weather. These characteristics have been transmitted to the synthetic variety and have resulted in substantial improvement as compared to the common Louisiana white clover. Seed production is equal or superior to that of the common white clover in Louisiana.

The improvements bred into Louisiana S1 white clover enable it to live through the summer and fall of most years and to revive from the stolons in the fall. It, thereby, is able to reach grazeable size from six weeks to two months earlier than ordinary white clover. It also may be grazed several weeks longer in the late spring and early fall.

Cultural methods for seed production with this clover as well as other white clovers are discussed.